REMARKS/ARGUMENTS

The Applicants note that claims 21-26 have been withdrawn as being directed to a non-elected species. However, it is submitted that these claims can be properly retained in the application, on the basis that there is a generic claim encompassing this species, and on this basis a new dependent claim 30 is being submitted.

It is noted that the Examiner has accepted the amendments to Figures 1 and 7 previously submitted.

The Examiner rejected claims 1, 2, 4-9, 19, 20, 27 and 28 under 35 U.S.C. 112, second paragraph, as being indefinite. More specifically, the Examiner argued that it was not clear whether independent claims 1 and 27 were directed to a method of humidifying a process gas, or to a method as applied to a process gas for a fuel cell.

In response, both claims 1 and 27 have been amended to refer to a method of humidifying "a process gas stream for a fuel cell". Additionally, at the end of each claim, acknowledging the antecedent "fuel cell" now present at the beginning of each claim, reference is made to "the fuel cell" (two occurrences in both claims). It is submitted that these amendments are fully responsive to this rejection.

The Examiner further noted that claim 5 appeared to be redundant; this claim is being deleted. The Examiner also noted that claim 6 appears slightly redundant. This claim is being retained, since it introduces a feature of providing a heating element along the supply line.

Finally, in response to the rejection of claim 19 under Section 112, the dependency of this claim has been amended, to make it dependent from claim 2 instead of claim 3.

The Examiner then rejected claims 1, 2, 4, 5, 7-9, 19, 27 and 28 as being obvious under 35 U.S.C. 103(a) in view of the combined teachings of JP 5-256468, Weitman and optionally, Fleck. This rejection is respectfully traversed for the reasons given below.

Firstly, the present invention is concerned with the humidification of a process gas stream for a fuel cell. As noted above, independent claims 1 and 27 have been amended to make this aspect of the invention clear, as claimed. In contrast, and as detailed below, much of the prior art is concerned with what in essence is conventional air conditioning equipment, and in one case air conditioning equipment for supplying air to a clean room. There are some fundamental differences between these two types of gas conditioning systems.

For the air conditioning system, for supplying conditioned air to a building or any sort or to a clean room, in general the volumes of air required are large. The air needs to be supplied at a relatively constant rate, and commonly, the specified conditions for the air, e.g. temperature and humidity are relatively constant. While individual users or, for individual clean room applications, there may be minor variations in the temperature and humidity settings, these are usually relatively small. More significantly, there is no requirement for precise and accurate control of the temperature and humidity. Even more significantly, there is, in general, no requirement to provide the ability to rapidly and frequently change the temperature and humidity conditions.

In contrast, the requirements for conditioning a process gas for a fuel cell are almost exactly the opposite. The quantities of gas, even for a large stack, are relatively small. It is commonly necessary for the temperature and humidity conditions to be very tightly controlled, since small variations in temperature and humidity can adversely affect fuel cell performance; more importantly, improper temperature and humidity conditions can result in damage to the fuel cell and/or to flooding leading to a drastic reduction in performance. Also, for many fuel cell applications, particularly applications in vehicles, the power demands on a fuel cell can vary rapidly, e.g. when a vehicle is stationary, there is no power demand and as soon as it is started, there can be a requirement for close to maximum power, which can be abruptly reduced when the vehicle reaches a cruising speed. For all these reasons, it is necessary to be able to change the temperature and humidity conditions quickly and accurately.

The present invention also has particular applicability to conditioning process gases in fuel cell test stations. In such test stations, the requirements, in many

respects can be even more stringent. In order to obtain accurate data, it is important that the precise values of temperature and humidity are known and recorded. More over, when testing fuel cells, it is common to subject them to extreme operating conditions, e.g. abrupt changes in load and the like, which in turn require abrupt changes in the process gas conditions.

With these requirements in mind, it can be seen that the techniques taught in the cited art, are, it is submitted, quite different from the present invention and in no way establish a proper prima facie obviousness rejection.

The Examiner first argued that Japanese '468 teaches many of the features of the present invention. The Examiner identified element 24 as a "steam source". The Japanese abstract in fact identifies this as a water vapor generator. The distinction is important. In the present invention, introducing steam introduces not only a considerable amount of humidity but also heat. Note that, for example as specified in claim 7, it is anticipated that the first temperature could be in the range of 10 to 100°C. No such temperature range is achievable with a simple water vapor generator.

In any event, this water vapor generator 24 is connected to a simple mixing tank 20. A tank such as this necessarily provides a large dead volume, which will give poor response times. In contrast, in the present invention, the steam is introduced directed into the flow stream, with minimal dead volumes, enabling rapid response. To emphasize this aspect of the invention, new dependent claims 29, 30 and 31, directed to this feature, are being submitted.

In JP '468, the humidified air is then passed to a cooling tank 25. Again, the suggestion is that there may be a significant dead volume, again adversely affecting response times. The apparent intent of this cooling tank 25 is to cause fine particles entrained in the vapor to be removed as droplets of water formed by condensation. In other words, the main intent is to remove dust particles and the like, rather than to control humidity levels.

This interpretation is enforced by the reference at 29, 30 to what the Examiner identifies as a humidity control 30 and a dew-point instrument 29. It is not

clear how these devices would work, but it is clear that the technique for controlling the humidity level is quite different from the present invention.

In contrast of the present invention, the process gas is cooled to a second temperature, to cause condensation of excess moisture, and it is this second temperature that sets the absolute humidity level. It is not seen how the technique in the Japanese reference could provide similar characteristics of rapid and accurate setting of the humidity level.

The Examiner cited the heater 31 for heating the process stream to the desired temperature.

The Examiner argued that in view of the teachings of Weitman, it would have been obvious to omit the dew-point instrument 25 from control of 30 in JP '468. This argument seems remarkable. It is these elements which provide for control of the absolute humidity level, and it is not seen how any precise control of the humidity level would be achievable without them.

Alternatively, the Examiner argued that it would have been obvious to replace the saturator unit 1 of Weitman with units 20, 24, 25, 27 and 28 of the JP '468 reference. The Examiner argued that this would have been obvious to reduce the overall size of the saturation section. This argument is respectfully traversed. It is not seen how replacing a single section of Weitman with the five separate elements identified in the Japanese reference would have in any sense reduced the overall size or complexity of the equipment. More specifically, there is simply no reason or basis to make this modification.

Again, both these references are, in one sense or another, simply concerned with providing conditioned air, i.e. air with a generally desired level of humidity and temperature. Given their intended uses, there is simply no need to be concerned with precise and accurate settings of temperature and humidity, nor any need to be concerned with providing the ability to rapidly track changes in humidity and temperature levels. Accordingly, it is submitted that there is no obvious combination of these two references, and that in any event any such notion or combination falls short of the invention as presently claimed.

The Examiner further argued that the step of providing a gas for controlled humidity and temperature to a fuel cell is well known in the art, and cited the Fleck patent in support. While Fleck may be concerned with humidifying a process gas to a fuel cell system, Fleck is noteworthy for teaching a relatively crude and simple scheme for achieving this. Given rapid developments in this field, Fleck is a relatively old reference, dating from more than ten years ago, which provides a compressor 3, a mixing chamber 4 and an injection nozzle 5 connected to a water supply line 6 for injecting water into the air stream. Air for atomization can be supplied through a line 8.

The only control element is the so-called control device 9 connected to the magnetic valve 7. It is stated, at column 2, lines 46-49 that "The magnetic valve is triggered via a control device 9, in which a desired valve for the quantity of water to be added is determined as a function of the relevant operating parameters."

The paragraph bridging columns 2 and 3 of Fleck is interesting. It contains a discussion of temperatures, heat effects and the like. It is noted that while the compressor will heat the air to a higher temperature, in general "the energy contained in the process air will not suffice to evaporate the entire quantity of water that is necessary..." It then notes that part of the water will then be transported in the liquid phase. This paragraph concludes, without explaining how this achieved, that "To ensure that the droplets passed through the narrow channels do not clog the cross-sections as they enter these channels, they should have a diameter in the range between 5 and 15 μm." (column 3, lines 5-9).

Accordingly, Fleck provides an extremely crude scheme for humidifying a process gas, and provides no accurate control on the final temperature and absolute humidity level.

The air conditioning systems of JP '468 and Weitman references are wholly unsuited for use in a fuel cell, for the reasons given above. They are concerned with relatively large volumes of air at atmospheric pressure. In contrast, Fleck is clearly concerned with compressed air at a pressure significantly above atmospheric pressure. Accordingly, it is submitted that there is no reason or basis to consider combining these references.

The Examiner further cited column 3, lines 28-34 of Fleck for teaching that, where the system is exposed to freezing temperatures, it can be provided with "suitable insulating measures or by a heating system." The only issue addressed here is problems due to freezing of water and water supplies. There is no discussion of the desirability of maintaining a temperature of a supply line to keep the heated process gas at a desired temperature. Indeed, Fleck is entirely silent on this topic, and the unstated implication in Fleck is that the mixing chamber 4 would be located sufficiently close to the fuel cell 1 that this would not be a problem.

In short, there is no clear recognition of this art of the problem of maintaining a process gas at a constant temperature, after it has left a heating and humidification section and before it is received at a fuel cell. The Examiner further cited Ebbing et al. and Othmer in support of the argument that it is obvious to provide heaters for long delivery pipes.

Again, it is submitted that this problem is not even clearly identified in this art and accordingly that the Examiner has failed to make a proper prima facie case obviousness. The Examiner argues that it is known to use heaters to prevent condensation etc. of gas components. The problem here is more subtle and more complex. In a fuel cell, it is desirable to ensure that any temperature and humidity levels established for the process gas are maintained closely. If the temperature drops, the relative humidity rises, while if the temperature rises the relative humidity drops. This issue is not even mentioned in the references cited by the Examiner. Accordingly, it is submitted that it is not in any sense obvious to provide this feature, as claimed in the present invention.

With respect to claim 20, the Examiner further relied upon the disclosure in Oswalt. This rejection is also respectfully traversed. Oswalt is concerned with a wholly different field, and it is submitted amounts to non-analogous art. Oswalt is concerned with a mechanically refrigerated chiller system for a process coolant. Again, this is concerned with chilling a process coolant on a large scale, for an industrial application. It is not concerned with a fuel cell system, where rapid temperature changes are required. Accordingly, it is submitted that claim 20 is not obvious.

Early and favorable review are requested.

Respectfully submitted,

BERESKIN & PARR

By ____________

H. Samuel Frost
Reg. No. 31,696
Tel:416-957-1687

Attachments